RESIDENTIAL APPENDIX RA11 - 2008

Residential Appendix RA11: Residential Indoor Air Quality Ventilation

Relevant Requirements of ANSI/ASHRAE Standard 62.2-2004
Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

3. DEFINITIONS

***acceptable indoor air quality*:** air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk.

***air cleaning*:** the use of equipment that removes particulate, microbial, or gaseous contaminants (including odors) from air.

***air, exhaust*:** air discharged from any space to the outside by an exhaust system.

***air, indoor*:** air in an occupiable space.

***air, outdoor*:** air from outside the building taken into a ventilation system or air from outside the building that enters a space through infiltration or natural ventilation openings.

***air, transfer*:** air moved from one occupiable space to another, usually through doorways or grilles.

***air, ventilation*:** outdoor air delivered to a space that is intended to dilute airborne contaminants.

***air change rate*:** airflow in volume units per hour divided by the volume of the space on which the air change rate is based in identical units (normally expressed in air changes per hour).

***balanced system*:** one or more fans that supply outdoor air and exhaust building air at substantially equal rates.

***bathroom*:** any room containing a bathtub, a shower, a spa, or a similar source of moisture.

***climate, hot, humid*:** climate in which the wet-bulb temperature is 67°F (19°C) or higher for 3500 hours or more, or 73°F(23°C) or higher for 1750 hours or more, during the warmest six consecutive months of a year that is typical for that geographic area (see Section 8.1).

***climate, very cold*:** climates that have more than 9000 annual heating degree-days base 65°F-day (5000 annual heating degree-days base 18°C-day). (See Section 8.1.)

***conditioned space*:** the part of a building that is capable of being thermally conditioned for the comfort of occupants.

***contaminant*:** a constituent of air that may reduce acceptability of that air.

***exhaust system*:** one or more fans that remove air from the building, causing outdoor air to enter by ventilation inlets or normal leakage paths through the building envelope.

***exhaust flow, net*:** flow through exhaust system minus the compensating outdoor airflow through any supply system that is interlocked to the exhaust system.

***habitable space*:** building space intended for continual human occupancy. Such space generally includes areas used for living, sleeping, dining, and cooking but does not generally include bathrooms, toilets, hallways, storage areas, closets, or utility rooms.

***heating degree-day*:** the difference in temperature between the outdoor mean temperature over a 24-hour period and a given base temperature of a building space. That is, for heating degree-day base 65°F (18°C), for any one day, when the mean temperature is less than 65°F (18°C), there are as many heating degree-days as degrees Fahrenheit (Celsius) temperature difference between the mean temperature for the day and 65°F (18°C). Annual heating degree-days are the sum of the heating degree-days over a calendar year.

***high-polluting events*:** isolated and occupant-controllable events that release pollutants in excess quantities. Typical cooking, bathing, and laundry activities are not considered high-polluting events.

***infiltration*:** uncontrolled inward leakage of air through cracks and interstices in any building element and around windows and doors of a building.

***kitchen*:** any room containing cooking appliances.

***mechanical cooling*:** reducing the temperature of a fluid by using vapor compression, absorption, desiccant dehumidification combined with evaporative cooling, or other energy-driven thermodynamic means. Indirect or direct evaporative cooling alone is not considered mechanical cooling.

***mechanical ventilation*:** the active process of supplying or removing air to or from an indoor space by powered equipment such as motor-driven fans and blowers but not by devices such as wind-driven turbine ventilators and mechanically operated windows.

***natural ventilation*:** ventilation occurring as a result of only natural forces such as wind pressure or differences in air density, through intentional openings such as open windows and doors.

***occupiable space*:** any enclosed space inside the pressure boundary and intended for human activities, including, but not limited to, all habitable spaces, toilets, closets, halls, storage and utility areas, and laundry areas.

***pressure boundary*:** primary air enclosure boundary separating indoor and outdoor air. For example, a volume that has more leakage to the outside than to the conditioned space would be considered outside the pressure boundary.

***readily accessible*:** capable of being quickly and easily reached for operation, maintenance, and inspection.

***source*:** an indoor object, person, or activity from which indoor air contaminants are released; or a route of entry of contaminants from outdoors or sub-building soil.

***supply system*:** one or more fans that supply outdoor air to the building, causing indoor air to leave by normal leakage paths through the building envelope.

***system*:** equipment and other components that collectively perform a specific function, such as mechanical cooling or ventilation.

***toilet*:** space containing a toilet, water closet, urinal, or similar sanitary service.

***utility*:** laundry, lavatory, or other utility room containing sinks or washing equipment.

ventilation: the process of supplying outdoor air to or removing indoor air from a dwelling by natural or mechanical means. Such air may or may not have been conditioned.

4. WHOLE BUILDING VENTILATION

4.1 Ventilation Rate

A mechanical exhaust system, supply system, or combination thereof shall be installed for each dwelling unit to provide whole-building ventilation with outdoor air each hour at no less than the rate specified in Table 4.1a and Table 4.1b or, equivalently, Equations 4.1a and 4.1b, based on the floor area of the conditioned space and number of bedrooms.

$$Q_{fan} = 0.01A_{floor} + 7.5(N_{br} + 1) \qquad (4.1a)$$

where

Q_{fan} = fan flow rate in cubic feet per minute (cfm),
A_{floor} = floor area in square feet (ft^2),
N_{br} = number of bedrooms; not to be less than one.

$$Q_{fan} = 0.05A_{floor} + 3.5(N_{br} + 1) \qquad (4.1b)$$

where

Q_{fan} = fan flow rate in liters per second (L/s),
A_{floor} = floor area in square meters (m^2),
N_{br} = number of bedrooms; not to be less than one.

Exception to Section 4.1: Whole-building mechanical systems are not required provided that at least one of the following conditions is met—

(a) the building is in a climate that has less than 4500°F-day (2500°C-day) infiltration degree-days as defined by *ANSI/ASHRAE Standard 119-1988 (RA94), Air-Leakage Performance for Detached Single-Family Residential Buildings*[1] (see Table 8.2.),

(b) the building has no central air conditioning and is in a climate having less than 500 heating °F-day base 65°F (280°C-day base 18°C), or
(c) the building is thermally conditioned for human occupancy for less than 876 hours per year—and if the authority having jurisdiction determines that window operation is a locally permissible method of providing ventilation.

TABLE 4.1a (I-P)
Ventilation Air Requirements, cfm

Floor Area (ft^2)	Bedrooms				
	0-1	2-3	4-5	6-7	>7

<1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

TABLE 4.1b (SI)
Ventilation Air Requirements, L/s

Floor Area (m^2)	Bedrooms				
	0-1	2-3	4-5	6-7	>7
<139	14	21	28	35	42
139.1-279	21	28	35	42	50
279.1-418	28	35	42	50	57
418.1-557	35	42	50	57	64
557.1-697	42	50	57	64	71
>697	50	57	64	71	78

4.1.1 Different Occupant Density. Tables 4.1a and 4.1b and Equation 4.1 assume two persons in a studio or one-bedroom dwelling unit and an additional person for each additional bedroom. Where higher occupant densities are known, the rate shall be increased by 7.5 cfm (3.5 L/s) for each additional person. When approved by the authority having jurisdiction, lower occupant densities may be used.

4.1.2 Alternative Ventilation. Other methods may be used to provide the required ventilation rates (of Table 4.1) when approved by a licensed design professional.

4.1.3 Infiltration Credit. Section 4.1 includes a default credit for ventilation provided by infiltration of 2 cfm/100 ft^2 (10 L/s per 100 m^2) of occupiable floor space. For buildings built prior to the application of this standard, when excess infiltration has been measured using *ANSI/ASHRAE Standard 136-1993 (RA 2001), A Method of Determining Air Change Rates in Detached Dwellings,*[2] the rates in Section 4.1 may be decreased by half of the excess of the rate calculated from Standard 136 that is above the default rate.

4.2 System Type
The whole-house ventilation system shall consist of one or more supply or exhaust fans and associated ducts and controls. Local exhaust fans shall be permitted to be part of a mechanical exhaust system. Outdoor air ducts connected to the return side of an air handler shall be permitted as supply ventilation if manufacturers' requirements for return air temperature are met. See Appendix B for guidance on selection of methods.

4.3 Control and Operation
The "fan on" switch on a heating or air-conditioning system shall be permitted as an operational control for systems introducing ventilation air through a duct to the return side of an HVAC system. Readily accessible override control must be provided to the occupant. Local exhaust fan switches and "fan on" switches shall be permitted as override controls. Controls, including the "fan-on" switch of a conditioning system, must be appropriately labeled.

Exception to Section 4.3: An intermittently operating, whole-house mechanical ventilation system may be used if the ventilation rate is adjusted according to the exception to Section 4.4. The system must be designed

so that it can operate automatically based on a timer. The intermittent mechanical ventilation system must operate at least one hour out of every twelve.

4.4 Delivered Ventilation
The delivered ventilation rate shall be calculated as the larger of the total supply or total exhaust and shall be no less than specified in Section 4.1 during each hour of operation.

Exception to Section 4.4: The effective ventilation rate of an intermittent system is the combination of its delivered capacity, its daily fractional on-time, and the ventilation effectiveness from Table 4.2.

$Q_f = Q_r/(\varepsilon f)$ (4.2)

where

Q_f = fan flow rate,
Q_r = ventilation air requirement (from Table 4.1a or Table 4.1b),
ε = ventilation effectiveness (from Table 4.2),
f = fractional on time.

If the system runs at least once every three hours, 1.0 can be used as the ventilation effectiveness. (See Appendix B for an example of this calculation.)

4.5 Restrictions on System Type
Use of certain ventilation strategies is restricted in specific climates as follows.

4.5.1 Hot, Humid Climates. In hot, humid climates, whole-house mechanical net exhaust flow shall not exceed 7.5 cfm per 100 ft^2 (35 L/s per 100 m^2). (See Section 8.1 for a listing of hot, humid U.S. climates.)

TABLE 4.2
Ventilation Effectiveness for Intermittent Fans

Daily Fractional On-Time, f	Ventilation Effectiveness, ε
f ≤35%	0.33
35% ≤f < 60%	0.50
60% ≤f< 80%	0.75
80% ≤f	1.0

4.5.2 Very Cold Climates. Mechanical supply systems exceeding 7.5 cfm per 100 ft^2 (35 L/s per 100 m^2) shall not be used in very cold climates.

Exception to Sections 4.5.1 and 4.5.2: These ventilation strategies are not restricted if the authority having jurisdiction approves the envelope design as being moisture resistant.

5. LOCAL EXHAUST

5.1 Local Mechanical Exhaust
A local mechanical exhaust system shall be installed in each kitchen and bathroom. Each local ventilation system shall be either one of the following two:

1. an intermittent mechanical exhaust system meeting the requirements of Section 5.2,
2. a continuous mechanical exhaust system meeting the requirements of Section 5.3.

Exception to 5.1: *Alternative Ventilation*. Other design methods may be used to provide the required exhaust rates when approved by a licensed design professional.

5.2 Intermittent Local Exhaust
An intermittently operating, local mechanical exhaust system shall be designed to be operated as needed by the occupant.

5.2.1 Control and Operation. Control devices such as, but not limited to, the following are permissible provided they do not impede occupant control: shut-off timers, occupancy sensors, multiple-speed fans, combined switching, indoor air-quality sensors, etc.

5.2.2 Ventilation Rate. The minimum airflow rating shall be at least the amount indicated in Table 5.1.

5.3 Continuous Mechanical Exhaust
A continuously operating mechanical exhaust system shall be installed to operate without occupant intervention. The system may be part of a balanced mechanical system. See Appendix B for guidance on selection of methods.

5.3.1 Control and Operation. The system shall be designed to operate during all occupiable hours. Readily accessible override control must be provided to the occupant.

5.3.2 Ventilation Rate. The minimum delivered ventilation shall be at least the amount indicated in Table 5.2 during each hour of operation.

TABLE 5.1 Intermittent Local Ventilation Exhaust Airflow Rates

Application	Airflow	Notes
Kitchen	100 cfm (50 L/s)	Vented range hood (including appliance-range hood combinations) required if exhaust fan flow rate is less than 5 kitchen air changes per hour.
Bathroom	50 cfm (25 L/s)	

TABLE 5.2
Continuous Local Ventilation Exhaust Airflow Rates

Application	Airflow	Notes
Kitchen	5 air changes per hour	Based on kitchen volume
Bathroom	20 cfm (10 L/s)	

6. OTHER REQUIREMENTS

6.1 Transfer Air
Dwelling units shall be designed and constructed to provide ventilation air directly from the outdoors and not as transfer air from adjacent dwelling units or other spaces, such as garages, unconditioned crawl spaces, or unconditioned attics. Measures shall be taken to prevent air movement across envelope components separating attached, adjacent dwelling units, and between dwelling units and other spaces, both vertically and horizontally. Measures shall include sealing of common envelope components, pressure management, and use of airtight recessed lighting fixtures.

6.2 Instructions and Labeling
Information on the ventilation design and/or ventilation systems installed, instructions on their proper operation to meet the requirements of this standard, and instructions detailing any required maintenance (similar to that

provided for HVAC systems) shall be provided to the owner and the occupant of the dwelling unit. Controls shall be labeled as to their function (unless that function is obvious, such as toilet exhaust fan switches). See Appendix A for information on instructions and labeling.

6.3 Clothes Dryers
Clothes dryers shall be exhausted directly to the outdoors.

6.4 Combustion and Solid-Fuel Burning Appliances
Combustion and solid-fuel burning appliances must be provided with adequate combustion and ventilation air and vented in accordance with manufacturer's installation instructions, *NFPA 54-2002/ANSI Z223.1-2002, National Fuel Gas Code,*[3] *NFPA 31-2001, Standard for the Installation of Oil-Burning Equipment,* [4] or *NFPA 211-2000, Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances,*[5] or other equivalent code acceptable to the building official.
Where atmospherically vented combustion appliances or solid-fuel burning appliances are located inside the pressure boundary, the total net exhaust flow of the two largest exhaust fans (not including a summer cooling fan intended to be operated only when windows or other air inlets are open) shall not exceed 15 cfm/100 ft² (75 Lps/100 m²) of occupiable space when in operation at full capacity. If the designed total net flow exceeds this limit, the net exhaust flow must be reduced by reducing the exhaust flow or providing compensating outdoor airflow. Atmospherically vented combustion appliances do not include direct-vent appliances.

6.5 Garages
When an occupiable space adjoins a garage, the design must prevent migration of contaminants to the adjoining occupiable space. Doors between garages and occupiable spaces shall be gasketed or made substantially airtight with weather stripping. HVAC systems that include air handlers or return ducts located in garages shall have total air leakage of no more than 6% of total fan flow when measured at 0.1 in. w.c. (25 Pa), using California Title 24 (2001)[6] or equivalent.

6.6 Ventilation Opening Area
Spaces shall have ventilation openings as listed below. Such openings shall meet the requirements of Section 6.8.

Exception: Spaces that meet the local ventilation requirements set for bathrooms in Section 5.

6.6.1 Habitable Spaces. Each habitable space shall be provided with ventilation openings with an openable area not less than 4% of the floor area nor less than 5 ft^2 (0.5 m^2).

6.6.2 Toilets and Utility Rooms. Toilets and utility rooms shall be provided with ventilation openings with an openable area not less than 4% of the room floor area nor less than 1.5 ft^2 (0.15 m^2).

Exceptions: (1) Utility rooms with a dryer exhaust duct; (2) toilet compartments in bathrooms.

6.7 Minimum Filtration
Mechanical systems that supply air to an occupiable space through ductwork exceeding 10 ft (3 m) in length and through a thermal conditioning component, except evaporative coolers, shall be provided with a filter having a designated minimum efficiency of MERV 6, or better, when tested in accordance with *ANSI/ASHRAE Standard 52.2-1999, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.*[7] The system shall be designed such that all recirculated and mechanically supplied outdoor air is filtered before passing through the thermal conditioning components. The filter shall be located and installed in such a manner as to facilitate access and regular service by the owner. The filter shall be selected and sized to operate at a clean pressure drop no greater than 0.1 in. w.c. (25 Pa) unless the equipment is designed or selected to accommodate any additional pressure drop imposed by the filter selection [i.e., greater than 0.1 in. w.c. (25 Pa)].

6.8 Air Inlets
Air inlets that are part of the ventilation design shall be located a minimum of 10 ft (3 m) from known sources of contamination such as a stack, vent, exhaust hood, or vehicle exhaust. The intake shall be placed so that

entering air is not obstructed by snow, plantings, or other material. Forced air inlets shall be provided with rodent/insect screen [mesh not larger than 1/2 in. (13 mm)].

TABLE 7.1 Prescriptive Duct Sizing

Duct Type	**Flex Duct**				**Smooth Duct**			
Fan Rating CFM @ 0.25 in. wg (L/s @ 62.5 Pa)	50 (25)	80 (40)	100 (50)	125 (65)	50 (25)	80 (40)	100 (50)	125 (65)
Diameter in. (mm)	**Maximum Length** ft. (m)							
3 (75)	X	X	X	X	5(2)	X	X	X
4 (100)	70(27)	3(1)	X	X	105(35)	35(12)	5(2)	X
5 (125)	NL	70(27)	35(12)	20(7)	NL	135(45)	85(28)	55(18)
6 (150)	NL	NL	125(42)	95(32)	NL	NL	NL	145(48)
7 (175) and above	NL	NL	NL	NL	NL	NL	NL	NL

This table assumes no elbows. Deduct 15 feet (5 m) of allowable duct length for each elbow.
NL = no limit on duct length of this size.
X = not allowed, any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop.

Exceptions to Section 6.8:
(a) Ventilation openings in the wall may be as close as a stretched-string distance of 3 ft (1 m) from sources of contamination exiting through the roof or dryer exhausts.
(b) No minimum separation distance shall be required between windows and local exhaust outlets in kitchens and bathrooms.
(c) Vent terminations covered by and meeting the requirements of the National Fuel Gas Code (*NFPA 54-2002/ANSI Z223.1-2002, National Fuel Gas Code*[3]) or equivalent.

6.8.1 Ventilation Openings. Operable windows, skylights, through-the-wall inlets, window air inlets, or similar devices shall be readily accessible to occupants. Where openings are covered with louvers or otherwise obstructed, openable area shall be based on the free unobstructed area through the opening.

7. AIR-MOVING EQUIPMENT

All air-moving equipment used to comply with this standard shall meet the following criteria:

7.1 Selection and Installation

Ventilation devices and equipment shall be selected using tested and certified ratings of performance, such as those provided by the Home Ventilating Institute Division of Air
Movement and Control Association International (airflow testing in accordance with *ANSI/ASHRAE Standard 51-1999/AMCA 210-99, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating*,[8] sound testing in accordance with *AMCA 300-96, Reverberant Room Method for Sound Testing of Fans*,[9] and product certification procedure in accordance with HVI 920-01, *Product Performance Certification Procedure*[10]) or other widely recognized testing and certification organizations. Installations of systems or equipment shall be carried out in accordance with manufacturers' design requirements and installation instructions.

7.2 Sound Ratings for Fans

Ventilation fans shall be rated for sound at no less than the minimum airflow rate required by this standard, as noted below.

7.2.1 Continuous Ventilation Fans. These fans shall be rated for sound at a maximum of 1.0 sone.

7.2.2 Intermittent Fans. These fans shall be rated for sound at a maximum of 3 sone, unless their maximum rated airflow exceeds 400 cfm (200 L/s).

Exception to Section 7.2: HVAC air handlers and remote-mounted fans need not meet sound requirements. To be considered for this exception, a remote-mounted fan must be mounted outside the habitable spaces, bathrooms, toilets, and hallways, and there must be at least 4 ft (1 m) of ductwork between the fan and the intake grille.

7.3 Airflow Rating

The airflows required by this standard refer to the delivered airflow of the system as installed and tested using a flow hood, flow grid, or other airflow measuring device. Alternatively, the airflow rating at a pressure of 0.25 in. w.c. (62.5 Pa) may be used, provided the duct sizing meets the prescriptive requirements of Table 7.1 or manufacturer's design criteria.

7.4 Multi-Branch Exhaust Ducting

If more than one of the exhaust fans in a dwelling unit share a common exhaust duct, each fan shall be equipped with a back-draft damper to prevent the recirculation of exhaust air from one room to another through the exhaust ducting system. Exhaust fans in separate dwelling units shall not share a common exhaust duct. Exhaust outlets from more than one dwelling unit may be served by a single exhaust fan downstream of all the exhaust inlets, if the fan is designed and intended to run continuously or if each outlet is equipped with a back-draft damper to prevent cross-contamination when the fan is not running.